WORKLOAD INDICATORS AT NAVY INVENTORY CONTROL POINTS

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THESIS

Workload Indicators at Navy
Inventory Control Points

by

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An investigation was made of the current system of budgeting and justifying Operation and Maintenance funds for staffing of Navy Inventory Control Points. The current procedures employed by the Navy Supply Systems Command in justifying Inventory Control Point staffing budget requests were analyzed. A new model with weighting factors for repairable and consumable item management was proposed and

an example made showing how the new model could contribute to improved budgetary procedures.

Workload Indicators at Navy Inventory Control Points

by

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ABSTRACT

An investigation was made of the current system of budgeting and justifying Operation and Maintenance funds for the staffing of Navy Inventory Control Points. The current procedures employed by the Navy Supply Systems Command in justifying Inventory Control Point staffing budget requests were analyzed. A new model with weighting factors for repairable and consumable item management was proposed and an example made showing how the new model could contribute to improved budgetary procedures.

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TABLE OF ABBREVIATIONS AND ACRONYMS

ASO-	Aviation Supply Office. The inventory manager responsible for the management of aircraft items and related equipments such as catapult and arresting gear, or ground support equipment.
CLAMP-	Closed Loop Aeronautical Management Program
COG-	Cognizance Symbol. A two position code prefixed to the Federal Stock Number to identify the type of material and the inventory manager.
COSAL-	Coordinated Shipboard Allowance List. Defines specific repair parts required to support both individual components and the ship as a whole.
DRIPR-	Issue restriction codes used in UICP. Disposal, Redistribution, Issue, Procurement, Repair.
DSA-	Defense Supply Agency. Centrally manages items common to all Military Services.
ESO-	Electronics Supply Office. The inventory manager that used to be responsible for Navy electronic items. ESO's functions have been transfered to SPCC.
FMS-	Foreign Military Sales
FMSO-	Fleet Material Support Office. Central design agency for uniform data processing system for Navy supply, principal Navy supply operations analysis group, financial manager of 9-COG material.
FY-	Fiscal Year.
IRAM-	Intensified Repairable Asset Management.
ICP-	Inventory Control Point. Responsible for program support of assigned equipment or components and the inventory management of assigned items. NAVSUP currently has two ICPs: ASO and SPCC.

TABLE OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

ILS- Integrated Logistic System.

MAP- Military Assistance Program. Also known as FMS.

MARK- A system of classification as to the cost and frequency of demand according to the following:

Mark 0 - less than 1 demand per year
Mark 1 - low cost (\$50), low demand (1-20/year)
Mark 2 - low cost (\$50), high demand (20/year)
Mark 3 - high cost (\$50), low demand (1-20/year)
Mark 4 - high cost (\$50), high demand (20/year)

NAVSUP- Naval Supply System Command.

O & M, N- Operation and Maintenance Funds, Navy. Funds managed directly by the end user and intended for the operation and maintenance of existing equipments and systems. This is contrasted to the appropriation for research, procurement of new equipment and military pay.

SPCC- Ships Parts Control Center. Responsible for the management of ships' items (Hull, Mechanical, and Electrical), conventional ammunition, non-expendible ordance items, and construction equipment items.

SYSCOM- System Command.

UICP- Uniform Inventory Control Program. A series of computer programs and manual routines used for purchase, requisition processing, requirements determination, load list preparation, and technical data recording.

WSF- Weapon System File. X Technical data files that are a part of UICP.

I. INTRODUCTION

For several years public and congressional sentiment has been making the job of Department of Defense budget submission and justification increasingly difficult. Even though the Department of Defense's percentage of the total United States budget has been decreasing, the dollars requested continue to increase. Navy budget managers and operators have been concerned with the relationship between staffing requirements and current workload indicators at Navy Inventory Control Points. The funding requirements for staffing of the Navy Inventory Control Points is currently over $100 million. Figure A shows a trend which is increasingly distressing, i.e., staffing requirements are increasing while the current workload indicators are decreasing.

Today's climate of austere funding, significantly decreased number of vessels, more sophisticated equipment, all volunteer armed forces, and continuing inflation has caused the Navy's budget managers and operators to seek a better way to substantiate the Navy's budget and inventory needs.

The object of this thesis is to investigate ways to improve the current system for requesting and budgeting O & M, N funds allocated for Navy inventory control points.

This will be accomplished by analyzing the current procedures, developing a new model to help in this element of the budgeting process, and indicating how the model can contribute to improved budgetary procedures.

BUDGET WORKLOAD AND STAFFING
TRENDS-ICP's

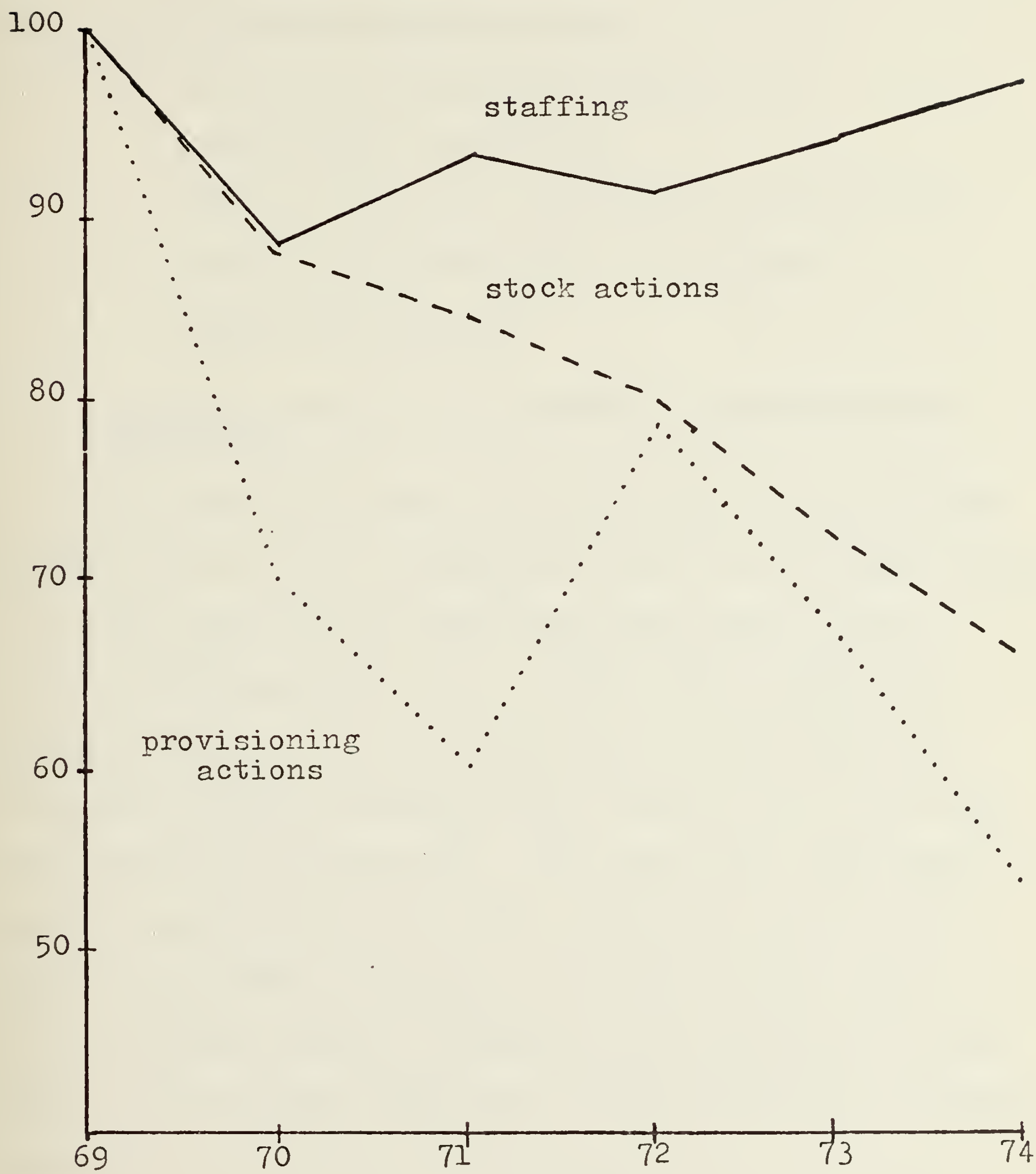

FIGURE A

II. THE PRESENT REQUEST AND BUDGET SYSTEM

The present request and budget system for Inventory Control Points relates the number of ships, aircraft, and military personnel to projected workload indicators. The system embraces the following:

1. Inventory Control Point budget and justification procedures.
2. The functions of an Inventory Control Point.
3. Factors not reflected in the current workload indicators.

A. INVENTORY CONTROL POINT BUDGET AND JUSTIFICATION PROCEDURES

The current procedures now employed to predict and justify the O & M, N Inventory Control Point budget element is a spin off from an elaborate model developed by Dunlap and Associates, Inc. in 1961 see Appendix A. This model which was developed prior to the Uniform Inventory Control Program (UICP) proved to be too large and unwieldy to work with. The Dunlap and Associates, Inc. model was refined to fit UICP by Cooper and Co. and a simplified model consisting of "Stock Actions" and "Provisioning Actions" developed and justified in 1964. These two workload indicators convert directly to budget dollars.

Stock Actions are defined as the total ships and aircraft supply items required for continuing support to Navy force levels of ships and aircraft in the operating fleet. Work under this category consists of such functions as reviewing stock actions, repositioning of material within the supply system, procurement, etc. The predominate workload factor and costs in this operation concern efforts related to stock actions. Supply support items related to new ships and aircraft initially introduced into the fleet are classified as Provisioning Actions. Workload under this category consists of such efforts as provisioning, identification, procurement, etc. There is a great deal of other work which is accomplished at Inventory Control points and one facet of the models in Chapter III is to account for this.

The budget submission and justification process begins one year prior to the start of the fiscal year for which the funds are to be allocated. The basic budget request is prepared by adjusting the current year budget apportionment for all known anticipated factors, such as wage board increases, functional transfers and price escalations. After a review on several levels a congressional submission is prepared. After hearings by congressional committees and final approval of an apportionment submission, the monies are available usually around the commencement of a fiscal year.

Funds for each program element are justified by relating some planned requirements to a forecast of projected costs.

Three measures are used to reflect the forces an Inventory Control Point must support. The number of COSAL items and support items is used to measure the force levels of ships and aircraft respectively. The number of active duty personnel is used as a direct measure. The number of support items has been found to be a better indicator than the number of ships or aircraft for the following reason. The total number of ships or aircraft could remain the same from one year to another but due to commissionings and deactivations the total number of support items could change drastically. A small scale example of this would be the deactivation of one diesel powered submarine, a loss of 8,000 items, balanced by the commissioning of a Fleet Ballistic Missile submarine, a gain of 40,000 items. Thus there would be the same number of vessels in the fleet and an increase of 32,000 support items. Naval Supply System Command showed that a high degree of correlation (.8717) exists between the force level composite index and the workload composite indicies [Ref. 1]

In order to obtain an indication of the change in forces an Inventory Control Point must support from one fiscal year to the next, an index for each force level

indicated is calculated by dividing the force level indicator of the outyear by the one for the base year. Table 1 shows the indicies for FY 1975 as .955 for ships, .990 for aircraft, and .978 for military personnel as the percentage change from the base year of 1974. When forecasting the number of stock actions the indicies from above are used as shown in Table 2 to derive the workload requirements.

The change in the annual rate of supply support to new ships and aircraft initially introduced into the fleet is computed as provisioning actions. The base year count of provisioning items reviewed is calculated from the number of items actually selected to be introduced as spares during that year. A historical percentage for each ICP is obtained from an annually updated five year average of items reviewed to the items selected. This percentage is then applied to the report of the number of items selected to obtain an estimate of provisioning items which reviewed during the base year. An index of 1.0 was used to relate both ships and aircraft provisioning workload since there was little change between FY 1974 and FY 1975 in the number of new aircraft support items and new ship construction/conversion support items. Table 2 shows the derivation of this workload requirement also. Table 3 shows how this would be calculated in a year with changes.

The costs of program support for weapon systems and other logistic programs to maintain fleet readiness and effect improvements in the supply management areas is estimated by taking base year support and adding known increases and thus presenting one figure which is essentially unjustified and unmeasured.

Table 4 shows the FY 1975 budget figures obtained by comparing workload and funds for the base year to projected workload to obtain a budget requirement. Changes are made to these figures to account for known factors, pay raises, etc. The final figure shows projected totals for other Navy management activities, Logistic Support programs and funds for facilities management.

TABLE I

SUMMARY OF FORCE LEVEL INDICIES UTILIZED IN COMPUTING FY 1975 APPORTIONMENT REQUEST WORKLOAD REQUIREMENTS:

	FY 74 (Base Year)	FY 75 (Estimate)
Ships		
Average Active Fleet Ships	548	510
Total Ships COSAL Items (000)	6,914	6,600
Index	1.0	.955
Aircraft		
Average Operating Aircraft	5,692	5,582
Total Aircraft Support Items (000)	447,860	443,310
Index	1.0	.99
Military Personnel		
Average Active Duty Military Personnel	558,000	546,000
Index	1.0	.978

TABLE 2

DERIVATION OF FY 1975 ICP WORKLOAD REQUIREMENTS

	FY 1974		Force Level Index		FY 1975 Estimate
Continuing Support (Stock Actions) (000)	3566				
Ships	1760	X	.955	=	1681
Aircraft	1860	X	.99	=	1788
Projected Workload					3469
Provisioning Items (000)	790				
Ships	625	X	1.0	=	625
Aircraft	165	X	1.0	=	165
Projected Workload					790

TABLE 3

ILLUSTRATION OF FY 1973 PROVISIONING WORKLOAD
FORCE LEVEL INDICIES

	FY 1971 Base Year	FY 1972	FY 1973
New Aircraft			
Total	828	525	506
Support Items (000)	74,733	65,989	63,000
Index	1.0	.883	.843
New Ship Construction/ Conversion			
Total	38	17	15
Support Items (000)	525	517	484
Index	1.0	.985	.921

TABLE 4

FUNDED WORKLOAD: ICP WORKLOAD THAT CAN BE ACCOMPLISHED WITHIN FUNDING APPROVED AS OF JUNE 1974

	FY 1974 Workload (000)	FY 1974 Funds (000)	FY 1975 Workload (000)	FY 1975 Funds (000)
Navy Item Management Activities				
Continuing Support	3533	28,799	3339	28,500
Stock Actions	790	17,020	790	17,139
Initial Support				
Provisioning Actions	____	____	____	____
		45,819		45,639
Other Navy Management Activities		1,172		1,238
Logistic Support Programs		41,698		50,714
Facilities Management		6,945		9,467
Total ICP		95,634		107,058
Unfunded Workload				
Continuing Support-Stock Actions	33	179	130	770

B. FUNCTIONS OF AN INVENTORY CONTROL POINT

The mission of an Inventory Control Point is the procurement and control of an inventory of repairable and consumable parts used for the repair of the Navy's Weapon Systems. This has generally included but has not been limited to budgeting and planning system inventories; procuring inventory; redistribution, reallocation, or disposal of inventory; reviewing demand for stocked and nonstocked items; procuring for the fleet items not currently in stock, or nonstocked items; providing technical information on repair parts; and preparing provisioning and allowance lists.

The two Inventory Control Points run by the Navy, Ships Parts Control Center (SPCC) and Aviation Supply Office (ASO), operate under a complex supply management system called "Uniform Automatic Data Processing System for Inventory Control Points" (UICP). This system not only responds to the acquisition, distribution, and issuance of supplies, but also provides current and accurate reports and analysis, to the limits of correct data to all levels of management within the Navy and the Department of Defense.

To assist in understanding the functions of an Inventory Control Point, the possible actions on a requisition are as follows:

When a requirement exists in the fleet, a requisition is initiated if the item is not available at the local supply activity, e.g., ship, Naval Air Station, etc. This requisition is forwarded to a Naval Supply Center which will supply the item or forward the requisition to the cognizant Inventory Control Point. If the item is issued at the Naval Supply Center, a report is sent to the cognizant ICP and the inventory records are adjusted at the ICP. Thus the items available in the supply system are reduced on the inventory records maintained by the ICP and the record will eventually appear for consideration in a supply demand review for possible procurement or more stock. When the unfilled requisition reaches the ICP it can be satisfied in several ways. If sufficient quantities are available at other Naval Supply Centers and there are no issue restriction codes, the computer can automatically refer the requisition to the appropriate Naval Supply Center. If there is not sufficient quantities available then the item manager can make a decision to backorder the requisition, procure the item for direct delivery or reconsign from an existing procurement.

There continue to exist persistant statements to the effect that there are large differences between the functions and the means by which these functions are accomplished at ASO and SPCC.

Contrary to this, all data seems to support just the opposite. Both centrally manage large volumes of inventory for the Navy. Both process requisitions, allowance lists, perform supply demand reviews, etc., with programs written by a single agency, the Fleet Material Support Office (FMSO), that have only to take into account minor structural and resultant management philosophy differences. It is claimed that ASO's business is primarily repairable. Approximately 22% of ASO's items are repairable, while over 25% of SPCC items are repairable. These items at ASO account for approximately 40% of ASO's demands, where the items at SPCC account for approximately 20% of SPCC's demand. Another contributing factor to the difference claims is the primarily verticle [1] organization at ASO and the primarily horizontal organization at SPCC. This thesis will not dwell on the respective advantages and disadvantages of each. An Item Manager in one organization could easily be transferred to a similar job in the other organization as could the purchasing agent or the technician.

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[1] The meaning of a verticle organization as used in this paper, is an organization where there is a member of each function within a single suborganization. For instance within a division there are item managers, procurement agents, technicians, etc. This is contrasted with a horizontal organization where all item managers are in one division, all procurement agents in another etc.

The extent and direction of verticle or horizontal organization seems to depend on and cycle as the Commanding Officer changes. SPCC seems to be moving towards a verticle organization with the Nuclear Equipment Support Division, Strategic Systems Support Division, Ammunution Division, and the proposed Trident organization all being verticle organizations. The last two even have their own main frame computer which they exercise extensive control over. ASO has a horizontal organization in it's administrative and staff support divisions and a verticle organization in it's operational divisions. Both seem to be gravitating towards a position with a mixed organization. Thus there seems to be no basis for the statements that the two Inventory Control points are organized differently.

C. FACTORS NOT REFLECTED IN THE CURRENT WORKLOAD INDICATORS

There are several factors which are germane to this area. The current workload indicators were developed during the initial implementation stages of UICP. They have not been updated since inception, with the result that a large portion of the current workload is unmeasured by the current system. An expanding requirement for support and a reducing emphasis on Item Management has resulted in only 41 per cent of Inventory Control Point staffing funds being related to the existing workload indicators.

The remaining part of the workload is unmeasured and directly related to the changing roles of Inventory Control Points. The staffing funds are particularly vulnerable to attack and difficult to defend. In the past these changes have been traditionally absorbed into overhead or hidden within the current workload. When these changes reach over 50 per cent of the budget it is time for action. A discussion of these factors is included here to give the reader a better understanding of the current system.

1. Changes in UICP and the roles of Inventory Control Points

Since these original workload indicators were developed UICP has undergone vast changes to accomodatc the changing role of Inventory Control Points and to take advantage of changes in the art of Data Processing and Management. The changing role has ranged from the incursion into ILS beyond the traditional role of an Inventory Control Point, the expansion of requirements levied by the SYSCOM's and the embracement of the concept of a Weapon System, to the expanded role of actively and intensively monitoring repairable transactions. From the outset UICP was innovative and advanced for its time. Unfortunately, the training funds so the average worker could learn to use the system were cut from the final budget. It was felt that the benefits of UICP were so great and with a little on-the-job- training the worker could learn to use the system.

The worker has learned to use this system to produce the old products he felt secure with.

2. The Weapon System File

The latest significant change to UICP is the approval and implementation of the Weapon System File (WSF) [Ref. 2]. With an impressive list of proposed random access files, the WSF will go a long way towards completing the full circle needed for an individual to extract all relevant data concerning a repair part or Weapon System for effective item management. More over it provides a composite cross file that enables checks on many data elements that currently cannot be easily checked. The files have been so constructed that changes to one file automatically generate changes to all other relevant files. This implementation will hopefully provide the impetus to modernize the "modus operandi" at the Inventory Control Points to take advantage of the abilities of the computer.

3. The Impact of Mechanization

The majority of individuals employed at an Inventory Control Point have not really changed their function because of mechanization. Most of these individuals use the computer and its output to justify the continuation of their small empire or "rice bowl". They have figured out a way to make the computer provide the needed output to keep their work counts up, where in reality a

significant portion of this work could actually be accomplished automatically by the computer. An example of this is the issue restriction or DRIPR codes and their effect on a requisition for an item in stock. A justification for the DRIPR codes existence will not be presented here. Once a DRIPR code is placed on an item it is rarely removed. Usually, only a few DRIPR codes are ever used when a large variety are available. Invariably, those used preclude any automatic processing of a requisition. The result is high work counts for the inventory manager, and a loss of 24 to 48 hours in requisition response time.

4. The Changing Mix of Repairable and Consumable Items

The mix of repairable versus consumable demand and population has been changing over a long period of time. Several factors have contributed to this change. As technology advanced our efforts to develop sophisticated weapon systems rapidly outstripped the ability of the average technician to repair them. As a result we have seen, especially in not only the aviation area but on an ever increasing scale throughout the Navy, the development of the "screwdriver" mechanic. This individual can test the black box with a piece of test equipment and based on the readings bless the black box as up and ready to go,

or replace the black box with a new or rebuilt one, usually using only a screwdriver as a tool and hence the terminology. These "screwdriver" mechanics generally do not possess the skill and/or education to tear the black box apart and repair it. This has led to the development of an elite of highly skilled and paid Navy and civilian technicians who specialize in this type of repair work. An attempt is not made to justify this change in repair philisophy but rather its impact on the supply system. Piece part support is needed for the highly skilled technician and a large number of complete assemblies are needed for the "screwdriver" mechanic. This has increased the demand and population of Navy managed repairable assemblies.

ASO has been showing an increase in the demand for repairable items at the rate of approximately 10 per cent per year. As the planned support system for the Patrol Frigate and Sea Control Ship developes, it appears that SPCC will show a significant jump in the area of repairable processing [Ref. 3]. This will be caused by a change in the demand patterns towards major assemblies vice piece part support. These assemblies which were formerly within the repair capabilities of ships forces will not have to be channeled through repair points.

In addition to the continued demand for piece part support, more major assemblies will be required so that the readiness of the vessels can remain high.

It has been recognized by high levels of NAVSUP that repairables require more and different management than consumables. Also their generally higher unit price makes them have a greater impact on the budget process. Dollars expended on repairables generally show a better return in cost savings and increased effectiveness.

5. DSA Migration

Another factor long overlooked is the item migration to DSA. DSA takes only those items which best fit the UICP forecasting model, i.e., those with a large, nearly constant normal demand that are generally inexpensive and are consumable. This means that those items which formerly provided stability to consumable demands are now being managed by DSA. Little wonder that when a DSA activity is compared to a service Inventory Control Point, the service activity comes up on the short end of the stick. When demands becomes erratic the item is returned by DSA to the service manager, usually with no assests in stock and a list of backorders. This migration means the ratio of repairable to consumable demands would show an increase just based on the decrease of consumable demands due to the loss of items to DSA.

Another side effect is that the consumables left to the service manager require more effort to properly manage.

6. Workload Counts

A problem with the present workload indicators is that the workload counts are based on action and not just a review. For this reason the system rewards an individual who orders a redistribution one month to move assets from Stock Point A to Stock Point B and then the next month orders them back again or other similar make work situations.

7. General Observations

As functions change the justification must change also. Functions have been changing radically at the Inventory Control Points but the workload measurement and budget justification have remained the same for over ten years. Our present era of inflation is not reflected at all in the present workload indicators. The result is a squeeze on operating funds at the end of a fiscal year as rising fixed costs consume more of the available funds.

Through past FMSO analysis [Ref. 4] it was shown that certain personnel are grossly under utilized but contribute significantly to through-put time. This same FMSO analysis shows through past statistics that slightly over 60 per cent of all requisitions reaching an Inventory Control Point are filled initially by automatic processing.

These requisitions are considered to be untouched by human hands, and their through-put times are measured in micro-seconds. In order for this to occur automatically, large volumes of data must be properly loaded, updated, and maintained. To complicate this process a large many of the Navy's ships and aircraft.

It has been shown in one section of SPCC, namely Strategic System Support Division code 890, that a properly funded and managed inventory control operation can be run by the computer with little intervention by the inventory manager. When the computer handles the requisitions and the supply demand reviews and recommendations are followed, an amazing thing happens. Budget justifications are easier, effectiveness goes up and stays up, and the programs actually work as advertised because there is nobody shortcircuiting the parameters because he "knows better". Code 890 is a special case where the required data was loaded and maintained, and the proper funding was available initially. It manages and maintains a data base on a small mix of repairable and consumable items which are fairly homogeneous among all Fleet Ballistic Missle submarines. There are several lessons to be learned from this; namely, standarized vessels must be constructed; data bases have to be maintained, loss of control of the data base results

in the system programs giving improper results; and Inventory Control Points must better utilize the tremendous computer resource they possess or they will loose them.

III. REVISIONS TO THE CURRENT PROCEDURES

As pointed out in Chapter II there are numerous areas for improvements in the current procedures. In In 1969 J. W. Prichard stated that productivity rates must be balanced with through-put times. [Ref. 5]. Increases in productivity lead to budget cuts requiring still higher utilization rates. In the final analysis readjustments of personnel assignments and job discriptions will be the only way Inventory Control Points can survive. This section discusses means to better utilize the existing procedures and proposes revisions to the traditional workload indicators.

A. THE WEIGHTING FACTORS TO ACCOUNT FOR THE CHANGING MIX

In an attempt to rectify the changing mix in repairables and consumables as pointed out in Chapter II, several proposals have been presented to NAVSUP. [Ref. 6]. In addition to investigating these areas, consideration was given to an attempt to an attempt to discover a non-linear relationship between the workload for repairables and consumables and their respective populations, but nothing meaningful was found. The best possible solution found for the immediate budget process was a weighting processed based on the linear programming solution to a

minimization of applicable costs for repairable versus consumable items. The current budget process as explained in Chapter II is easily adaptable to weighting factors.

The mathematics for the solution to the linear program are explained in Appendix B. By giving more weight to repairable transactions, the workload indicators can more truly reflect the actual workload. The weighting factor equalize time and effort expended in the proper management of a mixed inventory.

Table 5 shows the effect on the current FY 75 budget. The following formula is used to compute the factor:

$$Wr\ Dr + Wc\ Dc = F$$

where:

Wr is the weighting factor for repairables

Wc is assumed to be the base line and is equal to 1.

Dr is the per cent demand of repairable items

Dc is the per cent demand of consumable items

The result is a net increase of 16 per cent in the funded measure workload.

TABLE 5

	Wr	Dr	+	Wc	Dc	=	F
ASO	1.98	40%	+	1	60%	=	1.39
SPCC	1.98	22%	+	1	78%	=	1.22

Net effect on FY 75 budget submission (work load)

	Current	Model Effect
Stock Actions (000)	3608	4714
Ships	1748	2125
Aircraft	1860	2589
Provisioning Actions (000)	821	1033
Ships	625	760
Aircraft	196	273
		(funding 000)
Provisioning	17,077	21,478
Stock Actions	27,654	38,798
	44,731	60,276

B. PROPOSED REVISIONS TO THE TRADITIONAL WORKLOAD INDICATORS

In developing this model a close look was made at what constitutes a "Continuing Support Action" (Stock Action) and a "Provisioning Action". The model does not attempt to justify or maintain the status quo for current levels of staffing or ceiling points, but rather to justify workloads related to each show area where existing workload is not measured or at least not reported and make recommendations.

Incumbent on the success of this model is the on going existence of an Inventory Control Point in its apparent present form. Admiral Scott has stated that in order to be credible a model must eliminate as much unmeasured workload as possible. [Ref. 7]. It is not the purpose of this model to propose a large scale administrative system to count the actions of the personnel at an Inventory Control Point. As pointed out in Chapter II there is already too much of that which contributes to some of the current problems.

1. Definition of Model Terms

a. Material Management

This category will be split into two parts, repairable and consumable. It will include such actions as stratification, disposal, levels setting, backorder processing, transaction item reporting, supply demand review, requisition processing, financial accounting, inventory files maintenance, and procurement. For the present, the factors developed in the model can be applied to weighting. These weightings should be adjusted yearly to show differences in demand patterns and as realistic data can be documented the linear programming solution re-evaluated against measured time expenditures. There is no need for these factors to be the same for both ICP's, but it is reasonable to assume they will be close.

b. Provisioning Action

This will remain about the same as it is today including the initial procurement of spares/repair parts, preparation of initial outfitting lists, cataloguing, file load for new ships and aircraft on their initial introduction into the fleet.

c. Technical Support

This element includes maintenance of the technical data on the Weapon System File, material identification, standardization, engineering and special technical research, load lists, and composite and individual allowance lists.

d. Administrative Support

While all of the above areas have quantifible workload measurements this area presents more of a challenge. It will include such areas as ADP, Quality Control, Planning, Personnel Management, Management Engineering. Traditionally these areas have always been overhead. Comparisons need to be made between the functions in this area of Navy, DOD and Governmental wide installations to see if our input in these areas is producing any useful output.

e. Program Support

This is another hard area to quantify but at least it can be broken out by manhour expended on projects

such as Trident, IRAM/CLAMP, FMS, ILS, and others. What is needed is an intensive look by a higher authority such as NAVSUP or a SYSCOM and a determination made if the hours expended are commensurate with the product received.

f. Base Services

Those expenditures that are directly related to the operation and maintenance of grounds and buildings. A cost analysis needs to be done on the facilities utilized and comparable facilities available at other locations.

C. RESULTS AND RECOMMENDATIONS FOR USING THE PROPOSED REVISIONS

The figures used in the model were derived from the respective budget submissions by SPCC and ASO. Table 6 shows ASO's submission, Table 7 shows SPCC's submission and Table 8 shows the comparison to NAVSUP budget element. A chi squared nonparametric test was run on the results which showed there to be no significant difference at the .01 level of significance.

It would appear from the analysis made in this thesis that the current procedures used by NAVSUP to justify the Inventory Control Point O & M, N budget requests could be improved by use of a model similar to the one developed since the model developed was shown to predict at the .01 confidence level the same figures used by NAVSUP plus give a 16 per cent increase in funded workload by using only the two indicators presently used.

For future work with access to the proper data elements a correlation should be made to determine if a relationship exists between Technical Support items, reprovisioned items and/or vessels in overhaul. There may also be some basis to determine if a correlation between the Program Support items and proposed weapon system introductions into the fleet exists. These would enable gross budget adjustments based on a changing climate as is currently done for stock actions and provisioning actions as shown in Chpater II.

TABLE 6

ASO FY 75 BUDGET SUBMISSION

	FY74 (000)	FY75 (000)	FY75* (000)
Material Management	7961	9398	12959*
Provisioning	1445	1802	2405*
Technical Support	2224	2470	2470
Administration	18185	19768	19768
Base Services	5772	6646	6646
Program Support	4145	13487	13487
			57753

This table was computed by taking the man years associated with each of the subcategories from the FY 75 budget submitted by ASO and multiplying this by ASO's cost per man year. To this figure overtime dollars and non-labor dollars were added. *Figures have been adjusted by multiplying the repairable weighting factor computed in Table 5 times the man years. Similar calculations were computed for FY 73 and FY 74 and are displayed in Table 8. In each year the weighting factor was reduced based on input from ASO that its repairable business has been increasing approximately 10% per year, giving weights of 1.31 for FY 73 and 1.35 for FY 74.

TABLE 7

SPCC FY 75 BUDGET SUBMISSION

	FY74 (000)	FY75 (000)	FY75* (000)
Material Management	7144.	7717	9069*
Provisioning	1040	1349	1705*
Technical Support	6064	6704	6704
Administration	23082	27062	27062
Program Support	4553	4791	4791
Base Services		8276	8276
			57598

This table was computed by taking the man years associated with each of the subcategories from the FY 75 budget submitted by SPCC and multiplied by SPCC's cost per man year. To this figure was added overtime dollars and non-labor dollars. *Figures have been adjusted by multiplying the repairable weighting factor computed in Table 5 times the man-years. Similar calculations were computed for FY 73 and FY 74 and are displayed in Table 8. Constant weighting factor was used.

TABLE 8

COMPARISON COMPUTATIONS, ACTUAL SUBMISSIONS AND ACTUAL NAVSUP REQUEST

		MODEL	ACTUAL	REIMBURSABLE	NAVSUP
FY 75					
(000)	SPCC	57,598	58,558	9,000	
	ASO	57,753	55,121	2,561	
		115,351	113,679	11,561	105,642
FY 74					
(000)	SPCC	45,042	46,007	8,600	
	ASO	35,508	33,100	833	
	ESO*		13,706	684	
		80,550	92,813	10,117	96,902
FY 73					
(000)	SPCC	42,418	43,163	7,708	
	ASO	32,375	30,635	919	
	ESO*		11,518	642	
		74,793	85,316	9,269	95,077

* ESO was the Electronic Supply Office which has been absorbed into the functional areas of SPCC.

APPENDIX A

A SUMMARY OF A STUDY OF THE PROCUREMENT COSTS AT THE SHIPS PARTS CONTROL CENTER BY DUNLAP AND ASSOCIATES, INC.

Definition of terms:

A_h and A_p - Field Transactions Reports. Transactions (issues, receipts, dues, and obligations) that occured at field activities.

B_h - Action Forms. A review of system stocks on forms produced by EDPM equipment.

C_h and C_p - Replenishment Recommendations. Procurement recommendations made by Stock Control to replenish system stocks.

D_h - Passed Requisitions. Requisitions passed to the ICP by field activities.

E_h and E_p - NIS Purchase Requisitions. Requisitions for which system stock was not available and a decision was made to procure directly for the end user.

F_h and F_p - NSI Purchase Requisition. Nonstocked item (NSI) requisition which was procured directly for the end user.

G_h and G_p - Provisioning Items. Spare parts for equipment being placed aboard new construction or overhauled vessels which are procured for reserved system stock or directly for the end user.

H_h and H_p - Purchase Orders Not Processed by Buying. Unpriced purchased orders that are prepared in a simplified manner.

J_h and J_p - Other Purchase Orders. All other purchase orders processed by the buying branch.

K_h and K_p - Negotiated Contracts. Formal negotiated procurement contracts.

L_h and L_p - Advertised Contracts. Formal advertised procurement contracts.

M_h and M_p - Stock List. That work which is related to the processing of miscellaneous requests, cataloging, and the maintenance of records and files.

Subscripts h and p. refer to H-cog, hull mechanical and electrical parts, and P-cog, printed forms, paper and instructions.

Subscripts ah and ap. - Expenditures on Allowance and Lists. All work associated with the preparation of Shipboard Allowance Lists, Revised Individual and Type Allowance Lists, Allowance Parts Lists, Ship- to Component Records, and Load Lists for H-cog and P-cog material.

Subscripts nh, np, and nm - Expenditures on Nonpertinent Workloads. All work associated with special programs such as MAP and DIA (CIA) requisitions, Standardization, repairable management and others.

Subscript f - Fixed Expenditures. Fixed costs such as maintaining buildings are included in this item.

General Form of the Model.

Separate dollar cost functions were developed for the short run and for the long run. The short run is defined as that period of time during which personnel and facilities remain fixed.

General Form of the Model. (continued)

The principal dollar costs that may vary are the costs of machine rentals and the costs of paper, printed forms, and related supplies. The long run is defined as that period of time during which processing times and other measures of the quality of performance are fixed. Personnel and some facilities may vary but some facilities such as buildings are assumed to be fixed even in the long run.

The over-all short-run cost model for SPCC is:

$$T_s = 0.150A_h + 0.638A_p + 0.10C_h + 0.9C_p + 0.034D_h$$
$$+ 0.01E_h + 0.07E_p + 0101F_p + 0.032G_h + 0.008G_p$$
$$+ 1.05(H_h + H_h) + 1.09(J_h + J_p) + 3.00(K_h + K_p)$$
$$+8.51(L_h + L_p) + 0.78(M_h + 1.175M_p + 223,000_{ah}$$
$$+39,000_{ap} + 31,000_{ah} + 94,000_{nm} + 10,698,000_f$$

where T_s is defined as total short-run costs in dollars per year, and the other symbols are as defined earlier in this appendix.

APPENDIX A (CONTINUED)

The over-all long-run cost model for SPCC is:

$$T_l = 0.680A_h + 0.891A_p + 0.659B_h + 15.71C_h + 14.29C_p + 5.175D_h + 1.89E_h + 10.80E_p + 0.79F_h + 9.68F_p + 4.815G_h + 1.210G_p + 9.70\,(H_h + H_p) + 15.29(J_h + J_p) + 50.64(K_h + K_p) + 77.32(L_h + L_p) + 7.891M_h + 3.966M_p + 2{,}142{,}000_{ah} + 205{,}000_{ap} + 996{,}000_{nh} + 15{,}000_{np} + 242{,}000_{nm} + 2{,}805{,}000_f$$

Where T_l is defined as the total long-run costs in dollars per year and the other symbols are as defined earlier in this appendix.

APPENDIX B

LINEAR PROGRAMMING SOLUTION TO WEIGHTING REPAIRABLES VERSUS CONSUMABLES

Linear Programming is a mathematical representation which allows for the optimal allocation of limited resources among competing activities. The constraints imposed by the problem have to be able to be represented by linear functions. Constraints are the relationships among variables that restrict the values which are allowed.

The general equation can be written in the form:

$$\text{minimize} \sum_{j=1}^{n} c_j \; x_j$$

$$\text{subject to} \sum_{j=1}^{n} a_{ij} \; x_j = b_i \quad \text{for } i=1\ldots m \quad n$$

$$\text{and} \qquad x_j \geq 0 \;\forall\; j \qquad j=1,\ldots n$$

The restraint can be rewritten as:

$$\sum_{j=1}^{n} a_{kj} \; x_j - x_{n+k} = b_k$$

where $x_{n+k} \geq 0$ is called a slack or surplus variable.

Using a technique referred to as the Minimum θ [Ref. 8], the costs of the current basis may be reduced by introducing a vector into the current basis. Its placement can be determined by:

$$\min_{i \;\ni\; y_{i\sigma} > 0} \frac{x_{Bi}}{y_{i\sigma}} = \frac{x_{B\tau}}{y_{\tau\sigma}}$$

The Naval Postgraduate School has a Linear Programming routine [Ref. 9] developed by Professor R. Shudde stored on its Cambridge Monitor System (CMS) available to terminal users of the school's IBM 360-67 computer for solving linear programs. Into this program five months of ASO data from FY 1974 were feed. The data was as follows:

FY 1974 (000)	Consumable	Repairable	Manhours
July	111	67	158.7
September	96	68	149.4
October	99	68	173.7
November	101	65	159.8
December	81	62	138.3
TOTAL	490	330	779.9

The manhours were those reported by ASO in subfunction category A5, Supply Operations.

Using the total line as the objective function to be minimized:

$$Z = 490\ W_c + 330\ W_r$$

The constraints from the monthly data were:

$$111\ W_c + 67\ W_r + \text{Slack } 1 = 158.7 \qquad (1)$$

$$96\ W_c + 68\ W_r + \text{Slack } 2 = 149.4 \qquad (2)$$

$$99\ W_c + 68\ W_r + \text{Slack } 3 = 173.7 \qquad (3)$$

$$101\ W_c + 65\ W_r + \text{Slack } 4 = 159.8 \qquad (4)$$

$$81\ W_c + 62\ W_r + \text{Slack } 5 = 138.3 \qquad (5)$$

Other constraints were added:

$$W_r > W_c \qquad (6)$$

saying that the repairable weighting factor is always greater than the consumable factor:

$$W_r \leq 13.3\, W_c \qquad (7)$$

to account for the ideal number of repairable items and consumable items for an item manager. This was based on inputs from ASO and FMSO of 75 and 1000.

The program yeilded a weighting factor of 1.98 for W_r. This is the figure used as input in Table 5.

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